UNITED STATES DISTRICT COURT
SOUTHERN DISTRICT OF NEW YORK

UNITED STATES OF AMERICA, Plaintiff-Intervenor, – v. – COUNTRYWIDE HOME LOANS, INC., COUNTRYWIDE FINANCIAL CORPORATION, COUNTRYWIDE BANK, FSB, BANK OF AMERICA CORPORATION, BANK OF AMERICA, N.A., and REBECCA MAIRONE Defendants.	**Case No. 12-cv-1422 (JSR)**

DECLARATION OF ARNOLD BARNETT, Ph.D.

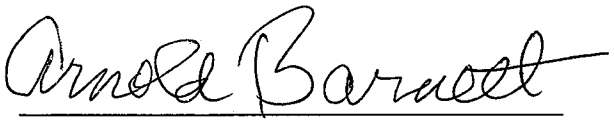
I, Arnold Barnett, Ph.D., pursuant to 28 U.S.C. § 1746 and based on personal knowledge of the facts stated herein, declare as follows:

1. I am over the age of 18 and fully competent to testify to the facts in this declaration.

2. I have been retained as an expert by counsel to the entity defendants in the above-captioned matter. I provided an Expert Report, dated June 18, 2013.

3. The document attached to this Declaration as Exhibit A is a true and correct copy of my June 18, 2013 Expert Report. I incorporate that report herein by reference. My June 18, 2013 Expert Report accurately reflects my opinions on the matters discussed in that report.

I declare under penalty of perjury that the foregoing is true and correct. Executed on July 12, 2013.



Arnold Barnett, Ph.D.

Exhibit A

UNITED STATES DISTRICT COURT
SOUTHERN DISTRICT OF NEW YORK

UNITED STATES OF AMERICA, Plaintiff, v. COUNTRYWIDE FINANCIAL CORPORATION; COUNTRYWIDE HOME LOANS, INC.; COUNTRYWIDE BANK, FSB; BANK OF AMERICA CORPORATION; BANK OF AMERICA, N.A.; and REBECCA MAIRONE, Defendants.	12 Civ. 1422 (JSR) ECF Case

EXPERT REPORT OF ARNOLD BARNETT, PH.D.

June 18, 2013

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I. QUALIFICATIONS

1. I am the George Eastman Professor of Management Science and Professor of Statistics at the Sloan School of Management, Massachusetts Institute of Technology. I hold a BA in Physics from Columbia University and a Ph.D. in Mathematics from MIT. My research specialty is applied statistical analysis. I have taught Probability and Statistics at MIT for over 35 years, and have also taught Biostatistics in the Harvard/MIT Clinical Investigators Training Program for nearly two decades. A web course has been created based on my Biostatistics course, and I am now writing a Probability and Statistics textbook under contract with John Wiley and Sons. My curriculum vitae is attached as Appendix A.
2. I have provided expert reports and testimony on numerous occasions in matters involving statistical sampling and analysis. Appendix A lists the cases in which I have testified at deposition or at trial in the last four years.

II. ASSIGNMENT

3. Counsel for the Entity Defendants[1] has asked me to review the Expert Report of Charles D. Cowan, Ph.D.,[2] in this proceeding, and to evaluate Dr. Cowan's sampling plan and analysis. In addition, counsel has asked me to use the rebuttal findings of Entity Defendants' expert

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[1] The Entity Defendants are Countrywide Financial Corporation, Countrywide Home Loans, Inc., Countrywide Bank, FSB, Bank of America Corporation, and Bank of America, N.A.

[2] Expert Report of Charles D. Cowan, Ph.D., *United States of America ex rel. Edward O'Donnell v. Countrywide Financial Corporation, et al.*, United States District Court, Southern District of New York, 12 Civ. 1422 (JSR), ECF Case, May 7, 2013 ("Cowan Report").

Robert Broeksmit[3] to calculate and compare the non-rebutted defect rates for High Speed Swim Lane ("HSSL") and non-HSSL loans.[4]

4. In working on this assignment, I have relied upon the documents and data listed in Appendix B. I am being compensated in this matter at a rate of $700 per hour. In addition, I receive compensation based on the professional fees of those working under my supervision and direction. Payment for my work and that of those working under my supervision and direction is not contingent on the opinions I express or the outcome of this matter.

5. My work in this matter is ongoing, and I may supplement my analysis should more information become available.

III. CASE BACKGROUND

6. Between January 2006 and December 2009, Countrywide's Full Spectrum Lending Division ("FSL") sold 249,459 loans to Fannie Mae and Freddie Mac (together, the "GSEs"). Certain of those loans were originated through the HSSL process. Plaintiff claims that Countrywide used the HSSL process "to increase the speed at which it originated and sold loans to the GSEs" and subsequently "eliminated every significant checkpoint on loan quality and compensated its employees based solely on the volume of loans originated, leading to rampant instances of fraud and other serious loan defects."[5]

7. Plaintiff's expert Charles Cowan selected a sample of loans from the population of 249,459 loans. Plaintiff's expert Ira Holt re-underwrote a portion of them. Dr. Cowan and Plaintiff's

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[3] Final Treliant Decisioning_061613 12 noon.xlsx.

[4] When I refer to HSSL and non-HSSL loans in this report, I am using Plaintiff's definition of the scope of the HSSL program. I take no position on which definition of the HSSL program is the correct one.

[5] United States of America v. Countrywide Financial Corporation *et al*, Amended Complaint, January 11, 2013, ¶ 2.

other experts analyzed the results from Mr. Holt's exercise, and Defendant's expert Mr. Broeksmit reviewed and rebutted Mr. Holt's findings of material defects. Though I reference the findings of both Mr. Holt and Mr. Broeksmit in this report, I take no position on whether they are accurate.

IV. SUMMARY OF OPINIONS

8. There is a sharp discrepancy between the sampling plan that Dr. Cowan describes at the outset of his report and the data analysis he presents later. For example, the original plan called for the review of 1,000 loans, while the analysis concerns only 526. Neither Dr. Cowan nor Plaintiff's other experts performed the analyses that Dr. Cowan's sampling plan was meant to support, and the lack of an explanation deviates from sound statistical practice.
9. To my great surprise, Dr. Cowan never performed the matched comparison that he contemplated between HSSL loans and non-HSSL loans. Neither did Plaintiff's other experts. I have done so, however, and I found that, even taking Dr. Cowan's and Mr. Holt's data at face value, the defect rate for HSSL loans was *lower* than that for non-HSSL loans. It is hard to see why Dr. Cowan and Plaintiff's other experts consider this outcome irrelevant, given that 40 percent of the original sample was chosen precisely to facilitate the comparison.
10. Furthermore, Dr. Cowan cited the observed defect rate among the 526 HSSL loans as justification for not following through on the original plan to sample 600 such loans. (Such further review, he declared, "would not be productive.") Dr. Cowan's use of an *ad hoc* and previously unstated "stopping rule" raises the danger of biased results and compromises the accuracy of his estimate of the defect rate in the HSSL population.

11. In any case, Dr. Cowan proposed a "stratified sampling" scheme with questionable characteristics. His discussion of the virtues of stratified sampling assumes a "proportional stratification," while he actually used a stratification procedure that was highly disproportional.

12. Dr. Cowan proposed to estimate defect rates within a margin of error of five percentage points. This standard is questionable in the context of this case, and, contrary to Dr. Cowan's assertions, his variant of stratified sampling was not guaranteed to meet it. Dr. Cowan did not even report a margin of error for his results, and I cannot compute one with confidence because the early termination of the sampling had unquantifiable consequences. However, it appears that Dr. Cowan experienced greater sampling error under his stratified scheme than he would have encountered with a purely random sample of the same size.

13. Because defect rates were higher among Dr. Cowan's HSSL loans that defaulted than among such loans that did not default,[6] Dr. Cowan's report encourages the reader to conclude that the defects raised the risk of default.[7] But this correlation does not prove causality, as Dr. Cowan admitted at his deposition. Nonetheless, Dr. Cowan made no attempt in his report to explore the possibility that the defective loans differed from the non-defective loans in other ways that pertain to the risk of default. This omission is especially puzzling because Dr. Cowan had used such variables as FICO score and loan-to-value ratio in his original experimental design, and I understand Plaintiff's other expert Daniel McFadden used such variables in his analysis.

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[6] Cowan Report, Table 3.

[7] Note that Dr. Cowan includes loans that were ever delinquent by 90 days or more in his "default" category. Cowan Report, Footnote 5, p. 12; Deposition of Charles D. Cowan, June 11, 2013 ("Cowan Deposition"), p. 64. I use Dr. Cowan's terminology in this report.

14. Finally, I have used the findings of Defendants' expert Mr. Broeksmit to recalculate and compare the "non-rebutted defect rates" for the various HSSL and non-HSSL strata. Mr. Broeksmit's assessments imply that the non-rebutted defect rate of HSSL loans is 4.3 percent, as compared to an estimated defect rate of 30.8 percent for the HSSL loans in the analyses conducted by Mr. Holt and Dr. Cowan. Mr. Broeksmit's non-rebutted defect rate for non-HSSL loans is 6.0 percent, which exceeds that for HSSL loans, but not to a statistically significant extent.[8]

V. DR. COWAN NEVER PERFORMED THE COMPARISON BETWEEN HSSL AND NON-HSSL LOANS THAT WAS A KEY COMPONENT OF HIS EXPERIMENTAL DESIGN

15. Early in his report, Dr. Cowan describes a sampling regimen involving 600 HSSL loans and 400 non-HSSL loans.[9] That design makes sense if the non-HSSL loans are to be treated as a control group for those in the HSSL category, providing a baseline "defect rate" that might have been anticipated had the different process used for the HSSL loan program not been used. Dr. Cowan indicates a clear intent to compare similarly-situated HSSL and non-HSSL loans when he says that he designed his stratification scheme to "make reasonable and justifiable comparisons between the findings of the re-underwriting comparing similar HSSL/Non-HSSL clusters of loans, e.g., defective rate for HSSL-Default-LTV<80% loans vs. defective rate for Non-HSSL-Default-LTV<80% loans."[10]

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[8] As I discuss below, the unusual manner in which the sample was truncated raises the danger of biased results and compromises the accuracy of Dr. Cowan's estimated defect rate in the HSSL population.

[9] Cowan Report, ¶ 5, p. 3.

[10] Cowan Report, ¶ 50, p. 19.

16. However, Dr. Cowan never reported the results of the HSSL/non-HSSL comparison that was central to his design. This despite the fact that 30 of the 60 "buckets" (i.e., strata) he proposed pertained to non-HSSL loans, and that extensive sampling of the non-HSSL loans was in fact undertaken.[11] At his deposition, Dr. Cowan stated that he was not asked to make this comparison but that other experts might.[12] But no one performed the comparison and not a word of explanation was offered. In the end, I cannot understand the large disconnect between the comparative analysis that Dr. Cowan planned and what he and Plaintiff's other experts actually reported.

17. As I will discuss, I have serious qualms about the analysis that Dr. Cowan performed on the 526 HSSL loans (out of the intended 600). Despite this, to approximate the comparison that Dr. Cowan did not perform, I applied his methods to the 865 HSSL and non-HSSL loans that Mr. Holt evaluated. My findings appear in Exhibit 1. I would call attention to the estimate of the overall defect rate of 40.0 percent for the population of non-HSSL loans as compared to the estimate of 30.8 percent for the population of HSSL loans.[13] (That difference is statistically significant, assuming that one treats the loans that Mr. Holt reviewed as random samples from the 1000 HSSL and non-HSSL loans in the original sampling plan.) In other

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[11] It is unclear why Dr. Cowan refers to some of these strata as "clusters" in his report. In sampling and statistics, "clusters" refer to higher-level categories that a statistician samples first before he samples individual elements from within the selected clusters. So, for example, a statistician may cluster by zip code, randomly select certain zip codes, and then sample individuals within the selected zip codes. Individuals in the zip codes not selected in the first stage do not have a chance to be sampled in the second stage. Dr. Cowan has not done anything like cluster sampling in this matter. At his deposition, Dr. Cowan acknowledged that he has undertaken stratification, not clustering. Cowan Deposition, pp. 61-63. For more on cluster sampling, see Stephen K. Thompson, "Cluster and Systematic Sampling," Chapter 12 in *Sampling*, Third Edition, John Wiley & Sons, 2012.

[12] Cowan Deposition, pp. 59-61.

[13] My estimated defect rate (30.8 percent) differs slightly from Dr. Cowan's estimate (30.6 percent excluding HARP loans and 30.7 percent including them). Dr. Cowan and I used the same data. I surmise that the reason for the slight difference is that Dr. Cowan did not properly take into account the fact that his sampling of loans from his FICO-based strata was not exactly proportional. An estimate of the overall defect rate should take this non-proportionality into account.

words, the HSSL loans had a *lower* defect rate than did comparable loans that were not processed in that manner. It is hard to see why Dr. Cowan or other Plaintiff's experts would find that difference irrelevant, given that so much of Dr. Cowan's sampling plan was aimed at estimating the difference.

VI. DR. COWAN DEVIATED FROM HIS SAMPLING DESIGN IN DRAWING INFERENCES ABOUT DEFECTS IN HSSL LOANS

18. As noted, Dr. Cowan had planned to work with results from a stratified random sample of 600 HSSL loans. His analysis, however, only concerned 526 of these loans. He offered the explanation that "with the preliminary results from the first 526 loans and the nature of the review conducted to date, the continued review of the loans remaining with full loan files would not be productive."[14]

19. It is not usual statistical practice to set out a plan for data gathering and analysis, and then prematurely to stop gathering data because fulfilling the plan would not be "productive." Such truncation can compromise the statistical accuracy of the results, and not merely because the sample size is reduced. Because the temptation to "quit while you're ahead" could yield a desire to end sampling early—a temptation that would *not* arise when early findings are adverse—analyses based on incomplete samples are discouraged because of potential bias.[15] The danger of bias is especially great when—as Dr. Cowan declares here—

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[14] Cowan Report, ¶ 82, p. 32.

[15] The implications of ending sampling and analysis early have been discussed in particular in the health outcomes literature. For example, a recent meta-analysis of 515 randomized control trials concluded that upward bias occurs when trials are stopped early. See Bassler *et al.* (2010), "Stopping Randomized Trials Early for Benefit and Estimation of Treatment Effects," *Journal of the American Medical Association*, Volume 301, No. 12, March 24/31, 2010. At his deposition, Dr. Cowan acknowledged that clinical trials are sometimes stopped early, depending on the results. But he does not discuss the implications, including potential bias, of stopping early. Cowan Deposition, pp. 104-105.

the "preliminary results" among the 526 loans were among the reasons the sampling program was terminated.[16]

20. Dr. Cowan's standard for early termination in his report—that further sampling would not be productive—is especially vague and unconvincing. Dr. Cowan expanded upon this justification at his deposition, arguing that his estimates of the defect rate would not have changed substantially even if Mr. Holt reviewed the remaining loans.[17] There is no basis for proceeding as if the 526 loans evaluated were a pure random sample from the 600 loans originally selected,[18] which means that one cannot apply the usual formulas to estimate HSSL defect rates or the margins of error in such rates.

21. Even a small bias in the estimation of the defect rate can have an appreciable impact on loss calculations. For example, consider the scenario that Dr. Cowan presented at his deposition.[19] Dr. Cowan hypothetically assumed that the defect rate among the HSSL loans that Mr. Holt did not re-underwrite was half the defect rate of the HSSL loans Mr. Holt reviewed.[20] Under these conditions, the estimate of the "true" defect rate in the population of HSSL loans would have been 28.9 percent, instead of 30.6 percent. Thus, Dr. Cowan's estimate based on only 526 loans would have been 5.9 percent too high (i.e., 30.6 – 28.9 = 1.7 as a percentage of 28.9). If the defect rate among the HSSL loans that Mr. Holt did not

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16 Cowan Report, ¶ 82, pp. 32-33.

17 Cowan Deposition, pp. 96-99.

18 At his deposition, Dr. Cowan admitted that he did not know how Mr. Holt selected which loans to re-underwrite. Cowan Deposition, pp. 96-97. In fact, based on his deposition testimony, it is not clear that even Mr. Holt understands how his team of re-underwriters chose which loans to re-underwrite and which loans not to re-underwrite. See Deposition of Ira Holt, June 11, 2013, pp. 297-303. Without knowing this process, there is no basis to conclude that the loans that Mr. Holt and his team finished re-underwriting were a random sample of the full sample of loans.

19 Cowan Deposition, pp. 98-100.

20 Because Dr. Cowan was discussing the post-extrapolation figures, it is a bit unclear what he means by 15 percent. I have assumed that Dr. Cowan means the new loans would in themselves have yielded a 15 percent defect rate estimate for the full population of HSSL loans. The final estimate would be a weighted average of this 15 percent rate and the 30.8 percent rate in those HSSL loans that Mr. Holt reviewed.

re-underwrite was zero, then the estimate of the "true" defect rate in the population of the HSSL loans would have been 27.5 percent, and Dr. Cowan's estimate based on only 526 loans would have been 11.3 percent too high. If losses are proportional to the defect rate, the bias in losses under these conditions would be appreciable. Dr. Cowan cannot dismiss this danger of bias because he precluded the collection of data that might dispel the possibility.

22. Quite apart from these issues, however, I see problems with the original sampling plan, as I explain below.

VII. DR. COWAN'S ACCURACY CRITERION IN HIS DATA ANALYSIS IS LESS STANDARD THAN HE SUGGESTS

23. Dr. Cowan proposed to estimate the overall defect rate for HSSL loans to within a five percentage point margin of error.[21] By this he means that the 95 percent confidence interval for the defect rate extends no more than five percentage points around the estimate itself. In essence, his proposed standard means that if the estimate is 40 percent, the chance is 95 percent that the true rate falls between 35 percent and 45 percent. He describes his accuracy criterion as "scientifically valid" and "standard in statistics."[22]

24. I agree that the 95 percent confidence interval is customary in Statistics (though I cannot opine on whether it is legally reasonable). But there is no clear reason for choice of a margin of error of ± 5 percentage points. For example, the Gallup polling organization currently uses a margin of error of ± 2 percentage points in its Presidential Job Approval poll, an

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[21] Cowan Report, ¶ 6, p. 3.
[22] Cowan Report, ¶ 6, p. 3.

extrapolation effort like the one in this proceeding.[23] And, according to publicly available information, Fannie Mae uses a margin of error of no more than ±3.1 percentage points for certain purposes, such as housing surveys, which, like the Gallup poll and Dr. Cowan's analysis, would be an extrapolation effort.[24] Therefore, it is excessive to say as Dr. Cowan does that a margin of error of ± 5 percentage points is "standard in statistics," let alone that it is automatically appropriate in this setting.

25. Furthermore, Dr. Cowan suggested at his deposition that the sample results might be used in loss calculations. In that context, a five percentage point margin of error in the estimated defect rate could create uncertainty in the loss estimate that substantially exceeds five percent. For example, if the defect rate is estimated as 30 percent with a five-point margin of error, then the confidence interval for the true rate extends from 25 percent to 35 percent. Because 35 is 40 percent higher than 25, the high-end estimate of losses would be 40 percent higher than the low-end estimate. 40 percent uncertainty is a far cry from five percent uncertainty.

VIII. CONTRARY TO WHAT HE SAID, DR. COWAN'S STRATIFIED SAMPLING PROCEDURE WAS NOT NECESSARILY AN IMPROVEMENT OVER SIMPLE RANDOM SAMPLING

26. Had Dr. Cowan taken a pure random sample of 600 HSSL loans (in which all loans had an equal chance of being selected for the sample), then he would have met his own accuracy standard: random sampling theory would have assured a margin of error below five percentage points in the overall defect rate. This means that, if Mr. Holt had evaluated the

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[23] See "Obama Job Approval (Weekly)," Gallup, available at <http://www.gallup.com/poll/125729/Obama-Job-Approval-Weekly.aspx>, accessed on June 13, 2013.

[24] See http://www.fanniemae.com/resources/file/research/housingsurvey/pdf/nhstechnicalnotes.pdf.

full population of HSSL loans and not simply the random sample, the probability that Dr. Cowan's estimate of the defect rate would differ from the actual rate by more than five points is less than five percent. (Of course, Mr. Holt's criteria for evaluating loans might be questioned, but that is not an issue related to statistical sampling *per se.)*

27. However, Dr. Cowan did not propose obtaining a random sample of HSSL loans. Instead, he argued that through the use of stratified random sampling he could achieve more accurate results than through a pure random sample.[25] Pursuant to that viewpoint, he took several distinct random samples of loans based on HSSL status, default status,[26] LTV ratios, and FICO scores. Dr. Cowan presented a chart (Chart 3) that suggested that stratifying on one variable could reduce margins of error by about 25 percent, while further stratification would yield sharply diminished returns.[27]

28. I would briefly point out that Dr. Cowan's Chart 3 bears no relation to any data analysis at issue in this case. It comes from a Statistics textbook, and is based on very specific assumptions about the relationships between stratifying variables and the quantity of interest.[28] There is no guarantee whatsoever that the first stratifying variable will cut the margin of error by 25 percent; nor is there any reason to believe that the second stratifying variable is inherently less consequential than the first.

29. However, what is more important is that Dr. Cowan blurred a key distinction in his discussion. When one engages in *proportional* stratification—in which the percentage of the sample from each stratum equals the percentage of the population from that stratum—then

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[25] Cowan Report, ¶ 6, p. 4; ¶¶ 36-37, pp. 14-15.

[26] Again, Dr. Cowan includes loans that are delinquent by 90 days or more in his "default" category. Cowan Report, Footnote 5, p. 12.

[27] Cowan Report, p. 24.

[28] William G. Cochran, *Sampling Techniques*, Third Edition, John Wiley & Sons, 1977, pp. 132-134.

stratified sampling cannot yield lesser accuracy than simple random sampling. But when one engages in disproportionate stratification, the results can suffer greater sampling error than a simple random sample of the same size. In this setting, Dr. Cowan engaged in highly disproportionate stratified random sampling: Only 130 of his original 600 HSSL loans (22 percent) were from his Stratum 3 (HSSL, not default, LTV < 80 percent), for example, even though this stratum included 62.5 percent of the HSSL population as defined by Plaintiff. Exhibit 2 presents the pattern of his disproportionate sampling in his HSSL-default-LTV-FICO strata and in his higher-level HSSL-default-LTV strata.

30. A simple example illustrates why disproportionate stratified sampling can be less accurate than simple random sampling. Suppose that it is desired to estimate the proportion of Americans who have Internet access, based on a total sample size of 1,000. A stratified alternative to simple random sampling would be to choose 900 residents of Vermont and 100 from the rest of the country. This stratification scheme would use a sample of size 100 to estimate the result for the 314 million Americans who are not Vermont residents, as opposed to a sample of about 998 out of 1000 for non-Vermonters under simple random sampling. Stratification's gain in accuracy in Vermont, in other words, would be more than paid for with a decline in accuracy for the 99.8 percent of Americans from other states. The upshot is a national statistic subject to greater sampling error.

31. This discussion is not merely theoretical. As I discuss below, Dr. Cowan's stratification increased rather than decreased the margin of sampling error in his results.

IX. DR. COWAN DID NOT EXPLAIN HOW HE IMPLEMENTED HIS STRATIFICATION, AND HIS ACCURACY LEVELS FALL BELOW THOSE UNDER SIMPLE RANDOM SAMPLING

32. Dr. Cowan justified his specific approach to disproportionate stratified sampling by stating that it would facilitate the estimation of separate defect rates for HSSL and non-HSSL loans.[29] Given that he never actually compared HSSL and non-HSSL loans, it is hard to interpret this statement. And given the premature end to sampling, it is hard to assign a margin of error to his results. But even under Dr. Cowan's assumptions, his stratified random sampling fell short of both simple random sampling and the accuracy standard he set.

33. Strangely, Dr. Cowan does not present in his report the margin of error that arose in his analysis, despite declaring at his deposition that he "ordinarily" does so.[30] I therefore undertook a calculation myself. As Exhibit 1 shows, I estimated a margin of error of ± 5.2 percentage points for Dr. Cowan's estimate of the defect rate of HSSL loans.[31] This statistic was based on the stratified random sample of 526 loans, and on Dr. Cowan's assumptions. In contrast, a pure random sample of 526 loans would suffer a maximum margin of error of ± 4.3 percentage points, which is 18 percent lower than Dr. Cowan's margin. Thus, Dr. Cowan's stratification did not achieve the reduction in sampling error that supposedly justified it. Nor did he even meet his accuracy standard of five percentage points.

34. As I said earlier, however, I am uncomfortable with performing usual calculations for the 526 loans given the unusual criterion by which sampling was truncated. I therefore believe the

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[29] Cowan Report, ¶ 50, p. 19.

[30] Cowan Deposition, pp. 93-95. Dr. Cowan testified that he believes the calculations of margins of error are present in his backup materials that Plaintiff produced in this matter. This does not appear to be the case.

[31] As discussed above, my estimate of the defect rate based on Mr. Holt's re-underwriting results is 30.8 percent, which differs slightly from Dr. Cowan's estimate (30.6 percent excluding HARP loans and 30.7 percent including them).

estimate of ± 5.2 percentage points for the margin of error might well be too low, for it fails to account for any bias from stopping the review of loans early.

X. DR. COWAN'S ANALYSIS SUGGESTING DEFECTIVE LOANS WERE MORE LIKELY TO DEFAULT THAN NON-DEFECTIVE LOANS IS INCOMPLETE AND UNCONVINCING

35. The primary results of Dr. Cowan's analysis appear in his Tables 1-3 and they indicate a correlation between the degree of defectiveness of a loan (none, modest, material) and the likelihood that it went into default.[32] Dr. Cowan does not explicitly state that defects in granting a loan caused its risk of default to increase, but that is the clear implication that the reader is encouraged to take from his tables.

36. It is a truism in Statistics that correlation is not causality: the fact that two variables move together in a data set does not mean that one of them is causing the movements of the other. Dr. Cowan admitted as much at his deposition.[33] In this instance, that warning seems especially pertinent. Dr. Cowan ignores all differences in loans other than their defectiveness classification, although one can imagine salient differences on other dimensions that could partially if not entirely explain observed differences in default rates.

37. A hypothetical example illustrates the issue. Suppose that FICO score is the prime determinant of default risk (the lower the score, the higher the risk), and that defects are heavily concentrated among loans with low FICO scores. Suppose further that the defects did not in themselves affect default risk. Then the loans that defaulted would have lower FICO scores (and higher defect rates) than those that did not default. Thus, the defect rate

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[32] Cowan Report, p. 29. Again, Dr. Cowan includes loans that were 90 or more days delinquent in the category of "default." Cowan Report, Footnote 5, p. 12.

[33] Cowan Deposition, pp. 118, 126.

would be higher among defaulted loans, even though the defects *per se* had nothing to do with the default. In this instance, one would wind up with tables like Dr. Cowan's. But the table would reflect a spurious correlation: Defect status was serving as a proxy for FICO score, the key explanatory variable that was omitted from the analysis.

38. I am not asserting that this particular problem explains the correlation on display in Dr. Cowan's Tables 1-3. My point is that Dr. Cowan is in no position to discount this example, because he paid no attention to the many dimensions on which defaulted loans might differ from others. This shortcoming (which in statistical parlance is called an "omitted variables" problem) is all the more surprising because Dr. Cowan spoke elsewhere of dividing loans into three categories based on LTV values and four categories based on FICO scores. Moreover, Plaintiff's expert Dr. Daniel McFadden recognized the importance of controlling for loan and borrower characteristics in analyzing the relationship between defect and loan performance in his report.[34] Dr. Cowan exhibits no such recognition in his report.

XI. AFTER INCORPORATING THE REBUTTAL FINDINGS OF MR. BROEKSMIT, THE NON-REBUTTED DEFECT RATE OF HSSL LOANS IS FAR LOWER THAN THAT OBTAINED IN THE ANALYSES CONDUCTED BY MR. HOLT AND DR. COWAN

39. I understand that Defendants' expert Mr. Broeksmit has reviewed the loans that Mr. Holt determined were materially defective and has rebutted a number of Mr. Holt's conclusions. Counsel for the Entity Defendants has provided me with Mr. Broeksmit's findings and has

[34] Corrected Expert Report of Daniel L. McFadden Report, ¶ 19, p. 7.

asked me to use those findings to estimate and compare the "non-rebutted defect rates" for the various HSSL and non-HSSL strata.[35] The results of my analysis are shown in Exhibit 3.

40. Mr. Broeksmit's assessments imply an estimated non-rebutted defect rate of 4.3 percent for HSSL loans, as compared to an estimated defect rate of 30.8 percent for HSSL loans in the analyses conducted by Mr. Holt and Dr. Cowan.[36] Mr. Broeksmit's findings imply an estimated non-rebutted defect rate of 6.0 percent for non-HSSL loans. I estimate the margin of error of the estimate of the non-rebutted defect rate to be ± 2.6 percentage points for HSSL loans and ± 3.1 percentage points for non-HSSL loans.[37] As with Mr. Holt's findings, the estimated defect rate for HSSL loans is lower than that for non-HSSL loans. However, the difference between the estimated non-rebutted defects rates for HSSL and non-HSSL loans using Mr. Broeksmit's findings is not statistically significant. As I discussed earlier, I am uncomfortable with performing margin of error calculations and statistical tests given the unusual criterion by which sampling was truncated, a problem that persists even after reconsideration of Mr. Holt's defect findings by Mr. Broeksmit and that may introduce bias in the estimated defect rates.

41. In addition, I have been asked to estimate the non-rebutted defect rate for all loans in Dr. Cowan's sample of 600 HSSL loans assuming Plaintiff has *not* shown those not underwritten

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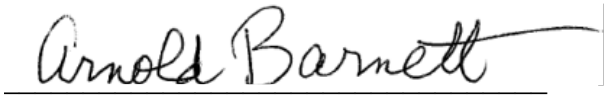
35 The "non-rebutted defect rate" is the proportion of loans (in a stratum or overall) that Mr. Holt found materially defective *and* that Mr. Broeksmit did not rebut. See Exhibit 3 for details.

36 The methodology I used to make these calculations is described in Exhibit 3.

37 The methodology I used to make these calculations is also described in Exhibit 3. I assume that, in any stratum, the Holt defect rate and the proportion of "Holt-defective" loans that Mr. Broeksmit's rebutted are independent random variables. I also assume that the variance of the non-rebutted defect rate in any HSSL/default/LTV/FICO stratum is zero when either Mr. Holt's defect rate in that stratum is zero or Mr. Broeksmit rebuttal rate in that stratum is 100 percent. The implication of this assumption is to decrease my estimated margin of error of the non-rebutted defect rate overall.

to be defective. Under this assumption, I estimate that the non-rebutted defect rate is 3.9 percent for HSSL loans, with a margin of error of ± 2.4 percentage points.



Arnold Barnett, Ph.D.

APPENDIX A

ARNOLD IRVIN BARNETT
Curriculum Vitae

George Eastman Professor of Management Science
Professor of Statistics
Sloan School of Management
Massachusetts Institute of Technology

abarnett@mit.edu
(617) 253-2670 (office), (617) 484-2660, (home)
E53-379, MIT, Cambridge MA 02139

Born:	April 21, 1948, Brooklyn, N.Y.
Citizenship:	U. S.
Education:	B. A. (Physics) Columbia College, 1969
	Ph.D. (Applied Mathematics) M.I.T., 1973
Thesis Title:	On Controlling Randomness in Transportation Systems
Thesis Advisor:	Professor Daniel J. Kleitman

Primary Research Interests: Operations Research, Applied Statistics, Applied Mathematical Modeling, Public Policy, Health and Safety

MIT Experience:

1971-73	Summer Session Instructor, Dept. of Mathematics, M.I.T.
1973-75	Instructor of Applied Mathematics, Dept. of Mathematics, M.I.T.
1975-78	Assistant Professor of Operations Research, Sloan School of Management, M.I.T.
1978-87	Associate Professor of Operations Research, Sloan School of Management (received tenure, May 1982)
1987-present	Professor of Operations Research, Sloan School of Management
1998	Named George Eastman Professor of Management Science

Outside Experience:

1973-75	U. S. Atomic Energy Commission (Bethesda, MD)
1975	Norton Publishing Co. (New York)

1975-90	Public Systems Evaluation Inc., Enforth (Cambridge)
1975	U. S. Dept. of Justice, Law Enforcement Assistance Administration (Washington)
1976-81	Tufts-New England Medical Center, Dept. of Hematology (Boston)
1978-81	U. S. General Accounting Office, Division of Energy and Minerals (Washington)
1980	Vermont State College System
1980	Citizens Crime Commission of New York City
1981	Professional Development Institute, Ltd. (Ottawa)
1982-84	National Center for State Courts (Williamsburg, Virginia)
1984	Manchester Business School (sabbatical)
1984-present	Educational Testing Service (Princeton, New Jersey)
1984-85	McKinsey and Company (London, Sydney)
1985	Australian Graduate School of Management (sabbatical)
1987	U. S. Sentencing Commission (Washington)
1987-95	KOBA Associates (Washington)
1988	Abt Associates (Cambridge)
1988	MacArthur Foundation/National Institute of Justice
1989	Centers for Disease Control (Atlanta)
1990-91	U.S. General Accounting Office (Washington)
1990-91	Federal Aviation Administration (Atlantic City)
1992-94	Burns and Levinson, Counsellors-at-Law, Boston
1992-3	Clinton and Musaka, Counsellors-at-Law, Boston
1993-present	Amsterdam Schiphol airport
1993	American Airlines
1993-present	Analysis Group (Cambridge)
1994	Goodwin Proctor and Hoar, Counsellors-at-Law, Boston
1994-95	Newsweek magazine
1994	CSSI (Washington)
1994	Liberty Mutual Insurance
1995-99	Computerworld magazine
1995	ATMS (Falls Church, VA)
1995	Ropes and Gray, Counsellors-at-Law, Boston
1995	Association of American Railroads
1996	Verner, Liipfert, Bernhard, McPherson, and Hand (Washington)
1996	Morgan-Stanley, Hong Kong
1996-present	Gell-Mann Research Associates (Philadelphia)
1997-present	Environmental Science Associates (San Francisco)
1997	Volpe National Transportation Center
1997	Coopers & Lybrand
1997	Holland & Knight Law Offices (Miami)
1998-2000	Federal Express Airlines
1999	Connecticut Home Care Association
1999	Locke, Liddell, and Sapp (Counselors at Law) (Houston)
1999-2001	Urban Institute (Washington)

1999-present	J.P. Morgan and Co.
1999-present	McNatt, Greene, and Thompson Law Offices (Vidalia, GA)
2000	Amsterdam Schiphol Airport, Committee on Crosswinds and Tailwinds
1999	University Access Inc. (Los Angeles)
2000	American Association of Actuaries
2000	O'Melveny and Myers (Los Angeles)
2000	Louisville International Airport
2001-present	Cornerstone Research, (New York, Los Angeles, San Francisco,Menlo Park)
2001	Flight Safety Foundation
2001	Jenner and Block, (Chicago)
2001	Simpson, Thacher, and Bartlett (New York)
2000-present	Sonnenschein, Nath and Rosenthal, (Kansas City, Chicago, St. Louis, New York)
2002	(US) Transportation Security Administration
2002	Wollmuth, Maher, and Deutsch (New York)
2002	Finnegan, Henderson, Farabow, Garrett, and Dunner (Washington)
2003	MCRI (Arlington, Virginia)
2004	Johnson and Johnson, Inc (New Jersey)
2004	Wilson, Sonsini, Goodrich, and Rosati (Palo Alto)
2004-07	Winston and Strawn (Chicago)
2005	Manatt, Phelps, and Phillips (New York)
2006	De Brauw, Blackstone, Westbroek (The Hague)
2007-present	Morrison and Forester (Sacramento)
2008-10	City of Los Angeles/Los Angeles World Airports
2009	Mintz, Levin, Cohn, Ferris, Glovsky, and Popeo (Washington)
2009	Howrey (Washington, DC)
2010-present	Grippo and Ellen (Chicago) and Butler, Rubin, Saletarelli, and Boyd (Chicago)
2011	City of New York
2011-12	Reed Smith (Chicago)
2011-12	Pepper Hamilton (Philadephia)
2011-present	Goodwin Procter (Boston)

MIT Administrative Activities:

(Institute) Committee on the Writing Requirement (1983-84)
(Institute) Committee on Curriculum (1986)
(Vice-Provost's) Committee to Review the Operations Research Center (1986)
Sloan Master's Program Committee (1983-84, 1985-86, 1990-92)
Sloan Core Coordination Committee (1985-86)
Chair, Sloan Ph.D. Program Committee (1986-88)
MIT Committee on Student Affairs (1987-88)
Operations Research Center, Core Faculty (1975-present)
Institute Committee on Minority Student Achievement (1999-2001)
MIT Medical Board, (2000-2002)
MIT Committee on Academic Performance (2005-present)

MIT Teaching Activities:

Courses Taught:

15.053	Introduction to Management Science
15.054	The Global Aviation Industry
15.060	Data, Models, and Decisions
15.061	Intermediate Statistics
15.063	Communicating with Data
15.064	Engineering Probability and Statistics
15.068	Advanced Statistics (until 2000)
15.068	Statistical Consulting
15.071	Decision Technologies for Managers
15.073/18.445	Introduction to Stochastic Processes
15.075	Applied Statistics
15.078J	Urban Operations Research/Logistics and Transportation Planning
15.813	Management Science and Public Systems
15.074	Mathematical Models and Policy Analysis
18.075/18.706	Advanced Calculus for Applications
18.303	Probability and Random Variables
18.312	Introduction to Statistics

Teaching Honors:

Selected twelve times by the students (most recently, May 2011) as recipient of a Sloan school or institute-wide Excellence in Teaching Award. One of eight U. S. faculty discussed in the article "B-School Students' Favorite Professors" in Fortune magazine of January 25, 1982. Ranked the most "outstanding" faculty member at the Sloan School in a 1992 Business Week poll of recent graduates. (The Best B-Schools, McGraw Hill, 1993, p. 165)

Research Activities

Research Awards and Honors: 1996 President's Award from Institute for Operations Research and the Management Sciences (INFORMS) for outstanding contributions to the betterment of society.

Selected as the 1999 honorary inductee into Omega Rho International Honor Society for scholarly contributions.

Selected by the British Operational Research Society as the year 2000 Blackett Memorial Lecturer; lecture was delivered at the Royal Aeronautical Society.

Recipient of the 2001 Expository Writing Award of the Institute for Operations Research and the Management Sciences (INFORMS) because influence of research was “greatly enhanced by its expository excellence.”

Recipient of 2002 President's Citation from the world-wide Flight Safety Foundation for "truly outstanding service on behalf of safety, whether it be valor, professionalism or other service above and beyond expectations."

Selected in 2003 as a Fellow of the Institute of Management Sciences and Operations Research.

Sponsored Research:

Principal Investigator of eleven research projects:

(1) "On Additional Approaches to Criminal Justice Data Analysis," awarded 4/78-4/80, Law Enforcement Assistance Administration; U. S. Dept. of Justice.

(2) "Mathematical Models and the Use of Prison Space," awarded 6/81 by National Institute of Justice, U. S. Dept. of Justice.

(3) "Selective Incapacitation and the Philadelphia Cohort Data," awarded 9/83 by National Institute of Justice, U. S. Dept. of Justice.

(4) "A Paradoxical Aspect of the Recent Decline in Crime Rates," awarded 10/86, National Institute of Justice, U. S. Dept. of Justice.

(5) "Assessing and Expanding the Set of Air Safety Risk Indicators," awarded 9/90, Federal Aviation Administration. (Renewed, 1/92)

(6) "World Airline Safety," awarded 1/97, Federal Aviation Administration.

(7) Co-Director, National Center of Excellence in Aviation Operations Research, (NEXTOR) founded 10/96.

(8) Chair, FAA Technical Committee on Positive Passenger Bag Match, which was established to deal with security issues raised by Gore Commission, 1996-98.

(9) Co-Director, Sloan Foundation Project on the Global Aviation Industry, 1999-present.

(10) Chair, Academic Panel, North Runway Safety Study, Los Angeles International Airport, 2008-present.

(11) Chair, MIT Conference on the Electoral College, sponsored by the Carnegie Corporation of New York, 2008.

Editorships:

Departmental Editor for Public Sector Applications, *Management Science*

Contributing Editor, *Interfaces*

Associate Editor, *Operations Research*

Editorial Board, *Journal of Quantitative Criminology*

Editorial Board Member, *Journal of Managerial Issues*

Co-Editor, Operations Research in the Public Sector, Elsevier-North Holland

Chair, *OR/MS TODAY* Committee

Publications:

"Optimal Scheduling Policies for Some Simple Transportation Systems," (with D. J. Kleitman), *Transportation Science*, Feb. 1973, pp. 85-99 Volume 7.

"On Scheduling Some Transport Systems with Discrete-Time Passenger Arrivals," *Studies in Applied Mathematics*, March 1973, pp. 75-86.

"Urban Violence and Risk to the Individual," (with D. J. Kleitman), *Journal of Research in Crime and Delinquency*, July 1973, pp. 110-116.

"On Operating a Shuttle Service," *Networks*, September 1973, pp. 305-313.

"On Controlling Randomness in Transit Operations," *Transportation Science*, May 1974, pp. 85-102 Volume 8.

"On Urban Homicide: A Statistical Analysis," (with D. J. Kleitman and R. C. Larson), *Journal of Criminal Justice*, Summer 1975, pp. 85-110. (A qualitative version of the above paper was published in Ekistics, February 1975. The paper's findings were the subject of the column "Grisly Prospects" in *The Wall Street Journal* of September 12, 1974.)

"More on a Market Share Theorem," *Journal of Marketing Research*, February 1976, pp. 104 109.

"On Searching for Events of Limited Duration," *Operations Research*, May-June 1976, pp. 438-451. Volume 24.

"Improved Interpretation and Analysis of Criminal Justice Statistics" (with R. D. Larson and A. Odoni) in Performance Measures and the Criminal Justice System: Four Conceptual Approaches, U. S. Dept. of Justice, Law Enforcement Assistance Administration, October 1976. (I wrote Chapter 8 of Part II of the book.)

"Control Strategies for Transport Systems with Nonlinear Waiting Costs," *Transportation Science*, May 1978, pp. 119-136. Volume 12.

"A Statistical Procedure for Testing Nuclear-Powered Cardiac Pacemakers," (with D. J. Kleitman, D. Rosenbaum, and B. Singer), *Technometrics*, August 1978, pp. 221-226.

"Optimal Control of the B/B/C Queue," (satirical) *Interfaces*, August 1978, pp. 49-52. Volume 8.

"On Two-Terminal Control of a Shuttle Service," (with D. J. Kleitman), *SIAM Journal on Applied Mathematics*, September 1978, pp. 229-234.

"Some Optimization Problems with Bulk-Service Queues," (with D. J. Kleitman), *Studies in Applied Mathematics*, Fall 1978, pp. 277-290.

"Crime and Capital Punishment: Some Recent Studies," *Journal of Criminal Justice*, Winter 1978, pp. 291-303.

"National Evaluation Program: Streetlighting Projects" (with J. Tien, V. S. O'Donnell, and P. B. Mirchandani), U. S. Government Printing Office #281-380-1551, Washington, D. C. (1979).

"Airline Safety: Some Empirical Findings," (with M. Abraham and V. Schimmel) *Management Science*, November 1979, pp. 1045-1056. Volume 25 (This paper was summarized under the title "Risk Assessment" in the *Scientific American* of August 1980.)

"The Decision to Perform Staging Laparotomy in Symptomatic Hodgkin's Disease," (with C. J. Rutherford, J. DesForges, and B. Davies) *British Journal of Hematology*, 44 p. 347-358 (1980).

"On the Sequential Search for Spatially-Distributed Events," (with J. Mazzarino), *SIAM Journal on Algebraic and Discrete Methods*, Vol 1, #1, March 1980, pp. 82-91.

"Urban Homicide: Some Recent Developments," (with E. Essenfeld and D. J. Kleitman) *Journal of Criminal Justice*, 8, pp. 379-85 (1980). (This paper was the subject of "The State of Murder in America," *Boston Sunday Globe*, 10/21/79, Focus Section.)

"The Dose-Response Relationship: What is its form at Low Levels?" and "Latency Period: Estimating the Time from the Induction to the Appearance of Cancer," Chapters 11 and 12 in Problems in Assessing the Cancer Risks of Low-Level Ionizing Radiation Exposure, Report EMD-81-1 to the Congress of the United States, U. S. General Accounting Office, 1981, pp. 11-1 to 11-34 and 12-1 to 12-18.

"The Deterrent Effect of Capital Punishment" A Test of Some Recent Studies," *Operations Research*, March-April 1981, pp. 346-370. Volume 28 (This article was summarized in the Op-Ed column "Capital Punishment: The Uncertainty Remains" in the Boston Sunday Globe of 9/3/79.)

"Further Standards of Accountability for Deterrence Research," Chapter 7 of Methods in Quantitative Criminology, J. Fox, Editor, Academic Press (1981), pp. 127-145.

"Evaluating the Validity of a Bayesian Model of Predicting Stage in Hodgkin's Disease," (with C. J. Rutherford, J. DesForges, N. Gutensohn, and B. Davies), *Methods of Information in Medicine*, 20, pp. 174-178 (1981).

"Learning to Live with Homicide," *Journal of Criminal Justice*, 10, pp. 69-72 (1982).

"An Underestimated Threat to Multiple-Regression Analyses Used in Job Discrimination Cases," *Industrial Relations Law Journal* (Berkeley [Boalt Hall] Law School) 5, #1, pp. 156-173 (1982).

"The Decision Between Single and Combined Modality Therapy in Hodgkin's Disease," (with C. J. Rutherford, J. DesForges, C. Safran, and B. Davies), *American Journal of Medicine*, February 1982.

"A Quartile Test for Differences in Distribution," (with E. Eisen), *Journal of the American Statistical Association*, 77, pp. 44-51 (1982).

1983 *Interfaces* columns:

"The Linear Model and Some of Its Friends," 13, pp. 61-65, February. Volume 13

"The Capital Punishment Controversy: Part I," pp. 24-28, June. Volume 13

"The Capital Punishment Controversy: Part II," pp. 35-39, November. Volume 13

"After the Crash: The Passenger Response to the DC-10 Disaster" (with A. J. Lofaso) *Management Science*, 24, pp. 1125-36 (November 1983).

1984 *Interfaces* columns:

"Mea Culpa," 14, pp. 24-28, March-April. Volume 14

"Hinckley and the Chemical Bath," (with I. Greenberg and R. Machol) pp. 48-52, July-August. Volume 14

"Newswatch," pp. 39-43, November-December.

"Selective Incapacitation and the Philadelphia Cohort Data," (with A. J. Lofaso), *Journal of Quantitative Criminology*, Vol. 1, #1, March 1985, pp. 3-36.

"Some Distribution Patterns for the Georgia Death Sentence," *U. C. Davis Law Review* (Death Penalty Symposium), Summer 1985, pp. 1327-74.

"Model-Based U. S. Prison Population Projections," (with T. Rich) *Public Administration Review*, November 1985, pp. 780-9.

1985 *Interfaces* columns:

"The Parable of the Red Line," (with A. Sapanaro), 15 pp. 33-39 March-April.

"Birth and Death Processes," pp. 34-38, July-August. Volume 15

"Before the Fall," pp. 60-65, November-December. Volume 15

"On the Optimal Allocation of Prison Space," (with A. J. Lofaso) Chapter 12 of Delivery of Urban Services, (TIMS series in the Management Sciences #22; A. J. Swersey, Editor), Elsevier North Holland Press, pp. 245-268 (1986).

1986 *Interfaces* columns:

"Speed Kills?" pp. 63-68, March-April. Volume 16
(This column was reviewed in *Mathematics* magazine (6/86) and was the basis of my op-ed piece "See Lightning? Shut Airports" in *The New York Times* of 6/26/86.)

"Ice Follies," pp. 91-95, July-August. Volume 16

"Prison Populations: A Projection Model," *Operations Research*, 35, pp. 18-34 (1987).

"Probabilistic Models of Youthful Criminal Careers," (with A. Blumstein and D. Farrington) *Criminology*, 25, pp. 83-107 (1987).

1987 *Interfaces* columns:

"Lightning Strikes Twice," pp. 21-26, March-April. Volume 17

"High Road to Glory," November-December. Volume 17

"Review of Prediction and Criminology (ed. by Farrington and Tarling)," *International Journal of Forecasting*, June 1988.

"Thunderstorms and Aviation Safety: A Dialogue," (with R. E. Machol) *Interfaces*, 26, March-April 1988.

"Crime News," *Interfaces*, May-June 1988.

"Wind Shear: Down but not Out," *MIT Management*, Summer 1988. Volume 18

"Heroin Crackdowns and Crime Rates: A Comment on the Kleiman Report and Two Massachusetts Experiments," Chapter 3 in Street-Level Drug Enforcement: Examining the Issues, National Institute of Justice, August 1988, pp. 37-46.

"Airline Safety: The Last Decade," (with M. K. Higgins) *Management Science*, January 1989, pp. 1-21. Volume 35

"Urban Homicide: Still the Same," (with E. Schwartz), *Journal of Quantitative Criminology*, March 1989, pp. 83-100.

"The Mystery of the Two-Faced Regression," (with P. Brownell) *Interfaces*, March-April 1989, pp. 56-60. Volume 19

"A Prospective Test of a Criminal Careers Model," (with A. Blumstein and D. Farrington), *Criminology*, May 1989, pp. 373-388.

"Dealing with Autism," *Interfaces*, May-June 1989, pp. 27-32. Volume 19

"Selecting the Nation's CEO: A Risk Assessment of the Electoral College," *Journal of Managerial Issues*, 2(4), 1990 (Invited paper; aspects of this analysis were widely cited in the press during the 1988 Presidential campaign.)

"Air Safety: End of the Golden Age?" *Chance*: New Directions for Statistics and Computing, 3 (2), 1990, pp. 8-13.

"Take the Bargain and Fly," *Advancing the Consumer Interest*, April 1990. (The negative side in a debate on whether the pernicious aspects of U.S. airline deregulation outweight the economic benefits it has brought to travelers.)

"Rain Men," with H. Tress, *Interfaces*, March-April 1990.

"It's Safer to Fly," *Risk Analysis*, 11(1) March 1991. Volume 13

"Smoke Signals," (with I. Greenberg), *Interfaces*, 21(6), Nov.-Dec.1991 (Misapplications Reviews). Volume 21

"Review of Equal Justice and the Death Penalty," *Ethics*, 102(1), October 1991.

An Unfortunate Pattern in U.S. Domestic Jet Crashes," (with T. Curtis). *Flight Safety Digest*, 10(10), October 1991. (This paper was the subject of the article "Fatalities Likelier on Crowded Jets" in *The New York Times* of 11/1/91.)

"Better than Ever: Nonstop Jet Service in an Era of Hubs and Spokes," (with T. Curtis, J. Goranson, and A. Patrick), Sloan Management *Review*, 33(2), Winter 1992. (This paper was the subject of the article "Why Airline Hubs Can Be Nice" in The Economist of 2/1/92.)

"Not All Criminal Career Models Are Equally Valid," (with A. Blumstein, J. Cohen, and D. Farrington), *Criminology*, February 1992.

"The Market Response to the Sioux City DC-10 Crash," (with J. Menhigetti and M. Prete), *Risk Analysis*, March 1992.

"America's Vietnam Casualties: Victims of a Class War?" (with T. Stanley and M. Shore), *Operations Research*, September-October 1992. Volume 40 (This paper was the subject of William F. Buckley's column "Vietnam: The Poor Man's War?" written 10/28/92.)

"Experience-Outcome Relationships in Heart Transplantation," (with G. Laffel, S. Finkelstein, and M. Kaye), *New England Journal of Medicine* (October 22, 1992).

"Landings at Logan Airport: Describing and Increasing Airport Capacity," (with C. S. Venkatakrishnan and A. Odoni), *Transportation Science* (July-August 1993).

"The On-Time Machines: Some Analyses of Airline Punctuality," (with J. Caulkins, J. Goranson, P. Larkey, and Y. Yuan), *Operations Research* (July-August 1993). Volume 41

"Something Specious in the Air? Some Statistical Misconceptions in Aviation Safety Research," *Transportation Research Record* #1423, (1994)

"Models Fail," Chapter 3 in Operations Research in the Public Sector (S. Pollock, A. Barnett, and M. Rothkopf, editors), Elsevier-North Holland, 1994.

“Business Schools: Failing Fast?” *Interfaces* March - April 1994 (short piece). Volume 24

“How Numbers Can Trick You: The Six Deadly Sins of Statistical Misrepresentation,” *Technology Review*, October 1994 (Cover Story).

“Crime and Justice Research,” (with M. Maltz) a section of Encyclopedia of Operations Research and the Management Sciences, Elsevier-North Holland 1996).

“Race, IQ, Genetics and The Bell Curve,” *OR/MS Today*, February 1995.

“Jail Terms,” *Interfaces*, March - April 1995 (Misapplications Reviews). Volume 25

“How Safe is This Flight?” *Newsweek*, 4/24/95 (I prepared the statistical tables that appeared in the article.)

“Good News is No News?” (with J. Goranson) *Interfaces* (May-June 1996). Volume 26

Review of the book A Mathematician Reads the Newspaper, *Technology Review* (Feb.-March 1996)

"Valujet and Travel Safety," report contained within written testimony of Valujet President Lewis Jordan to Transportation and Infractstructure Committee, U.S. House of Representatives, June 1996. (This report was also presented to the U.S. Senate, to the U.S. Department of Transportation, and to the Circuit Court of Appeals for the District of Columbia.)

"The Affirmative Action Debate," *OR/MS Today*, August 1996.

"Beauty and the Beast: A Visit to South Africa," *ROI*, October 1996.

"Safety in Numbers: Some Statistics about Plane Crashes and Their Consequences," Proceedings of the International Conference on Aviation Safety and Security in the 21st Century, sponsored by the White House Commission on Aviation Safety and Security, January 1997.

Review of Efficiency of Racetrack Betting Markets, *Interfaces* (Jan-Feb 1997). Volume 27

Review of Cartographies of Danger, *Technology Review*, October 1997.

"The Feline Great Mystery," (electronic presentation for high-school math students) at:

http://morning-star.mit.edu/felinegreat

"Some Ultimate Risks," (electronic presentation for college students under the CHANCE project of the National Science Foundation), at: <http://www.dartmouth.edu/~chance/Chance Lecture/RIEL>.

“The Patron Saint of Operations Research,” (testimonial) *OR/MS TODAY*, June 1998.

“A Hero is Nothing but Bob Machol,” (testimonial) *OR/MS TODAY*, February 1999.

"A Parallel Approach Path for Estimating Collision Risk During Simultaneous Landings", *Management Science*, March 1999, Volume 45.

Review of Misused Statistics, *Chance*, March 2000, Volume 14.

“Airline Safety: The Recent Record,” (with A. Wang), *Flight Safety Digest*, April 2000. (This paper was the subject of my op-ed piece: “Flying? No Point in Trying to Beat the Odds.” In *The Wall Street Journal* on 9/9/98.)

Review of Capital Punishment: A Reader, *Ethics*, July 2000.

Foreword to Understanding Aviation Safety Data, (SAE, 2000).

“It’s a Crime What Some People Do with Statistics,” *The Wall Street Journal* (op-ed), August 30, 2000.

"Free-Flight and En Route Air Safety: A First-Order Analysis", *Operations Research*, November-December 2000, Volume 48.

"Fatal US Runway Collisions Over the Next Two Decades," (with G. Paull and J. Iaedeluca) *Air Traffic Control Quarterly*, 8(4), 2000.

"The Cost of Cancer to a Major Employer," with P. Cremieux and M. Slavin, *American Journal of Managed Care*, November 2000.

"Safe at Home? An Experiment in Domestic Airline Security." (with R. Shumsky, M. Hansen, A. Odoni and G. Gosling, *Operations Research*, March-April 2001, Volume 49.

"Air Safety?: End of the Golden Age?," *Journal of the Operational Research* Society, August 2001, Volume 52. (This paper is based on the year 2000 Blackett Memorial Lecture, which I presented in November 2000 at the Royal Aeronautical Society in London.)

"The Worst Day Ever: September 11 and Commercial Aviation," OR/MS TODAY, December 2001.

"Anemia-Related Costs for Cancer Patients," with P. Cremieux, A.M. Fendrick, M. George, and M. Slavin, *Journal of Managed Care Medicine* 2001, 5 (12).

"Bag Match: At Last," *Congressional Record*, 1/23/02 (testimony to House Aviation Subcommittee, US House of Representatives).

"A New Approach to Estimating the Probability of Winning the Presidency," (with E. Kaplan), *Operations Research* January-February 2003, Volume 51.

"Trust No One at the Airport," *OR/MS TODAY*, February 2003 ("Last Word" column).

"Dose Conversion from Epoetin alfa to Darbepoetin alfa for Patients with Chronic Kidney Disease Receiving Hemodialysis" (with P. Cremieux), *Pharmacotherapy*, Spring 2003

"Aviation Security's False Hope?" *MIT Technology Insider*, May 2003 (and *TechnologyReview.com* August 2003).

"Terror is In the Air," (with S. Martonosi), *Chance*, (American Statistical Association) Spring 2004 Volume 18.

"CAPPS II: The Foundation of Aviation Security?" *Risk Analysis* (August, 2004) Volume 24.

"Assessing the Effectiveness of Aviation Safety Measures in the Absence of Actual Data," (with G. Paull), *Air Traffic Control Quarterly* (Fall, 2004) Volume 12.

"World Airline Safety: The Century So Far," *Flight Safety Digest* (January-February 2006) Volume 33.

"O.R. Heroes on Flight 93," OR/MS TODAY, August 2006.

Applied Statistics for Clinical Researchers, Web course for medical doctors, funded by Pfizer and Merck for worldwide distribution. Final version released in August 2006. (The link is http://hstelearning.mit.edu/appstats/; anyone can register and get access.)

"Airlines as Baseball Players: Another Approach to Evaluating Air Carrier Safety Records," (with D. Czerwinski), *Management Science*, September 2006, Volume 52.

"How Effective is Security Screening for Airline Passengers?" (with S. Martonosi), *Interfaces* (Special Issue on Homeland Security), November-December 2006, Volume 36.

"A Cure for the Electoral College?" (with E. Kaplan), *Chance* (American Statistical Association), Spring 2007, Volume 20.

(This paper was excerpted in the op-ed piece of the same name in the *San Diego Union Tribune* of May 17, 2009, as part of a web-page debate.)

"Match the Bags Again," *Airport Innovation*, April 2007 (inaugural issue).

"Measure for Measure: An Analysis of Aviation-Safety Metrics," *AeroSafety World* (Flight Safety Foundation), (November 2007).

"Is It Really Safe To Fly?" Chapter 2 in *Tutorials in Operations Research 2008*, (Institute for Operations Research and the Management Sciences).

Aviation Safety and Security," Chapter 11 in *The Global Airline Industry* (P. Belobaba, A. Odoni, and C. Barnhard, editors), pp. 313-342, John Wiley & Sons (2009).

"Selecting the Nation's CEO: A Risk Assessment of the Electoral College," *Journal of Managerial Issues*, pp. 447-460, 21(4) ,Winter 2009 (This article was reprinted as part of a tribute to the Founding Editor on his retirement: He selected his seven favorite articles from those published by the journal in the last twenty years.)

"Use Body Scan Machines," invited contribution to "What's Missing in Aviation Security?" Room for Debate Blog, *The New York Times*, 12/28/09.

"Cross-National Differences in Aviation Safety Records," *Transportation Science*, 44(3), pp. 322-332, August 2010 (This paper was summarized in 30+ newspapers around the world.)

"Resist the Complainers," invited contribution to "Do Body Scanners Make Us Safer?," Room for Debate Blog, *The New York Times*, 11/23/10.

"Aviation Safety and Security," *Wiley Encyclopedia of Operations Research and the Management Sciences*, March 2011 (This article is not the same as the one with the same title above.)

"Southwest Jet Rupture and Flight Risk," *CNN Opinion*, April 4, 2011.

"US Urban Homicide: Yesterday's Crisis?" submitted for publication.

"Collision Course? The North Airfield Safety Study at Los Angeles International Airport" (with M. Ball, G. Donohue, M. Hansen, A. Odoni, and A. Trani), submitted for publication. (This paper is a succinct version of the North Airfield Safety Study at Los Angeles International Airport (LAX), which was prepared by a Panel that I chaired. The full report is available at the LAX website.)

"Did Nate Silver Beat the Tortoise?" *Analytics*, January 2013 and *OR/MS Today*, February 2013 (forthcoming).

"Has Terror Gone to Ground?" submitted for publication.

Applied Probability and Statistics, a textbook to be published by John Wiley and Sons. The manuscript has been completed except for final revisions, and publication is slated by 2014. The prospectus implied that the book is appropriate for…well, everyone.

Legal Testimony in Recent Years

"Intel Corporation Microprocessor Antitrust Litigation"
Federal Matter
Howrey (Washington DC), Bingham McCutchen (San Francisco)
Nature of Case: Alleged Anticompetitive Behavior by Intel
Role: Expert Witness, Declaration, Deposition 2009-2010

"U.S. Department of Justice v. Massachusetts Department of Correction"
Federal Matter
Office of the Attorney General, Commonwealth of Massachusetts
Nature of Case: Alleged gender discrimination in testing for
Correction Officers
Role: Expert Reports, Deposition, 2010

"Merck and Co: Vytorin/Zetia Securities Litigation"
Federal Matter
Pepper Hamilton (Philadelphia)
Nature of Case: Alleged "stalling" in releasing results of clinical trial
Role: Expert Reports, Deposition, 2011

"Countrywide vs. Republic Mortgage Insurance Company,"
American Arbitration Association
Reed Smith (Chicago)
Nature of Case: Default Risk in Mortgage Loans
Role: Expert Report, Deposition, Testimony, 2012

"MBIA Insurance Corporation vs. Countrywide Home Loans et al"
State Matter
Goodwin Procter (Boston)
Nature of Case: Alleged Material Defects in Loan Approvals
Role: Expert Report, Deposition, 2012

"Chicago Parking Meters LLC vs. City of Chicago"
American Arbitration Association
Winston and Strawn (Chicago)
Nature of Case: Parking Revenue Loss Because of Exemptions for Handicapped Parkers
Role: Expert Report, Deposition, Testimony, 2012

"MassMutual vs. DB Structured Products, Inc., et al."
United States District Court for the District of Massachusetts
Cravath, Swaine & Moore LLP
Nature of Case: Statistical Sampling of Mortgage Loans from Mortgage Backed Securities
Role: Expert Declaration, Deposition, 2013

APPENDIX B
MATERIALS CONSIDERED

Complaint

Amended Complaint of the United States of America in *United States v. Bank of America Corp.*, 12 Civ. 1422 (JSR)

Expert Reports and Depositions

Expert Report of Charles D. Cowan, Ph.D, May 7, 2013 (including backup files)

Expert Report of Ira H. Holt, Jr.. May 7, 2013 (including backup files)

Corrected Expert Report of Daniel L. McFadden, Ph.D, June 6, 2013

Updated and Corrected Expert Report of Joseph R. Mason, Ph.D, May 31, 2013

Deposition of Charles D. Cowan, June 11, 2013

Deposition of Ira H Holt Jr. June 11, 2013

Academic Articles and Books

Stephen K. Thompson, "Sampling.", Chapter 12, Third Edition, *John Wiley & Sons*, 2012

Bassler Dirk, Matthias Briel, *et al.* , "Stopping Randomized Trials Early for Benefit and Estimation of Treatment Effects." *Journal of the American Medical Association*, Volume 301, No. 12, March 24/31, 2010, available at http://jama.jamanetwork.com/

William G. Cochran "Sampling Techniques." Third Edition, *John Wiley & Sons*, 1977

John A. Rice "Mathematical Statistics and Data Analysis." Second Edition, *Duxbury Press*, 1955

Publicly Available Documents

"Obama Job Approval," Gallup Daily, available at http://www.gallup.com/poll/125729/Obama-job-approval=weekly.aspx

"Fannie Mae National Housing Survey – Technical Notes." *Fannie Mae*, March, 2013, available at http://www.fanniemae.com/resources/file/research/housingsurvey/pdf/nhstechnicalnotes.pdf

Additional Data

FINAL TRELIANT DECISIONING_061613 12 noon.xlsx

Exhibit 1
Defect Rates by Cowan Stratum

Cowan Stratum	Stratification Variable 1	Stratification Variable 2	Stratification Variable 3	Not Materially Defective (Holt)	Materially Defective (Holt)	Material Defect Rate (Holt) [1]	Margin of Error Assuming that Re-Underwritten Loans Were a Random Sample of All Sampled Loans [2]	P Value, Test of Equality of Defect Rates [3]
1	HSSL	Default	LTV < 80%	82	58	41.1%	8.1%	0.529
2	Non-HSSL	Default	LTV < 80%	36	31	45.8%	12.2%	
3	HSSL	Not-Default	LTV < 80%	94	25	21.2%	7.4%	0.146
4	Non-HSSL	Not-Default	LTV < 80%	63	27	30.3%	9.7%	
5	HSSL	Default	LTV = 80%	19	8	28.7%	16.1%	0.919
6	Non-HSSL	Default	LTV = 80%	21	9	29.9%	17.7%	
7	HSSL	Not-Default	LTV = 80%	21	6	23.0%	17.3%	0.207
8	Non-HSSL	Not-Default	LTV = 80%	15	10	40.5%	20.8%	
9	HSSL	Default	LTV > 80%	40	92	70.0%	7.6%	0.843
10	Non-HSSL	Default	LTV > 80%	23	50	68.6%	10.9%	
11	HSSL	Not-Default	LTV > 80%	31	50	61.6%	10.9%	0.496
12	Non-HSSL	Not-Default	LTV > 80%	24	30	55.5%	13.7%	
All Sampled HSSL Loans				287	239	30.8%	5.2%	0.022 **
All Sampled Non-HSSL Loans				182	157	40.0%	5.8%	

Exhibit 1 (Continued)
Defect Rates by Cowan Stratum

Notes

[1] Let *h* index the HSSL or non-HSSL stratum, *i* index default/LTV stratum within HSSL or non-HSSL stratum, and *j* index FICO stratum within HSSL/default/LTV stratum.

The estimated material defect rate in HSSL-Default-LTV stratum *hi* is:

$$r_{hi} = \sum_{j=1}^{5} W_{hij}\, r_{hij}$$

where

r_{hij} = Holt defect rate within stratum *hij*,

n_{hij} = the number of loans in the population in stratum *hij*,

n_{hi} = $\sum_{j=1}^{5} n_{hij}$, the number of loans in the population in stratum *hi*, and

W_{hij} = $\frac{n_{hij}}{n_{hi}}$

Similarly, the estimated material defect rate for HSSL (or non-HSSL loans) is:

$$r_h = \sum_{i=1}^{6} W_{hi}\, r_{hi}$$

where

n_h = $\sum_{i=1}^{6} n_{hi}$, the number of loans in the population in stratum *h*,

W_{hi} = $\frac{n_{hi}}{n_h}$

and other variables are as defined above.

[2] Assuming that the loans that Mr. Holt re-underwrote were a random sample of the loans that Dr. Cowan sampled, the margin of error of the estimated defect rate r_{hi} in HSSL-Default-LTV stratum *hi* is:

$$MOE_{hi} = \pm 1.96\sqrt{S_{hi}^2}$$

where

s_{hij} = the number of loans in stratum *hij* sampled by Dr. Cowan and re-underwritten by Mr. Holt,

$S_{hij}^2 = \left[\frac{r_{hij}(1-r_{hij})}{s_{hij}-1}\right]\left[1-\frac{s_{hij}}{n_{hij}}\right]$, the estimated variance of the defect rate r_{hij} ,

$S_{hi}^2 = \sum_{j=1}^{5} W_{hij}^2 S_{hij}^2$, the estimated variance of the defect rate $r_{hi,}$

and other variables are as defined in Note [1].

Similarly, the margin of error of the estimated defect rate for HSSL (or non-HSSL) loans is equal to

$$MOE_h = \pm 1.96\sqrt{S_h^2}$$

where

$S_h^2 = \sum_{i=1}^{6} W_{hi}^2 S_{hi}^2$, the estimated variance of the defect rate $r_{h,}$

and other variables are as defined as above and in Note [1].

[3] The p-value is the p-value of a two-sided test of the equality of defect rates, assuming the defect rates are independent normally distributed random variables.

Let $h = 0$ indicate non-HSSL loans and $h = 1$ indicate HSSL loans. To test the equality of defect rates in like default/LTV stratum, I construct a test statistic as follows:

$$t_i = \frac{|r_{1,i} - r_{0,i}|}{S_{\Delta hi}}$$

where

$r_{1,i}$ = the estimated defect rate in HSSL stratum i,

$r_{0,i}$ = the estimated defect rate in non-HSSL stratum i,

$S_{1,i}^2$ = the estimated variance of the defect rate $r_{1,i}$,

$S_{1,i}^2$ = the estimated variance of the defect rate $r_{0,i}$,

$S_{\Delta hi}^2$ = $S_{1,i}^2 + S_{0,i}^2$, the estimated variance of the difference in defect rates,

$S_{\Delta hi}$ = $\sqrt{S_{\Delta hi}^2}$, the estimated standard deviation of the difference in defect rates,

and other variables are as defined as above.

The distribution of the test statistic t_i is assumed to be normal for the computation of the p-value of the test.

Similarly, to test the equality of defect rates between HSSL and non-HSSL loans, I construct a test statistic as follows:

$$t = \frac{|r_1 - r_0|}{S_{\Delta h}}$$

where

r_1 = the estimated defect rate of HSSL loans,

r_0 = the estimated defect rate of non-HSSL loans,

S_1^2 = the estimated variance of the defect rate r_1,

S_0^2 = the estimated variance of the defect rate r_0,

$S_{\Delta h}^2$ = $S_1^2 + S_0^2$, the estimated variance of the difference in defect rates,

$S_{\Delta h}$ = $\sqrt{S_{\Delta h}^2}$, the estimated standard deviation of the difference in defect rates,

and other variables are as defined as above.

Again, the distribution of the test statistic *t* is assumed to be normal for the computation of the p-value of the test.

Sources

[1] 2013.05.02 Final Data File.csv, file produced by Plaintiff.
[2] 2012-12-27 – Data to SDNY – US v Bank of America – Confidential.xlsx, file produced by Plaintiff.
[3] Sample.r, file produced by Plaintiff.
[4] John A. Rice, *Mathematical Statistics and Data Analysis*, Second Edition, Duxbury Press, 1995.

Exhibit 2
Population Sizes and Sample Size by Cowan Stratum

Stratification						Findings				
Cowan Stratum	Stratification Variable 1 (HSSL/Non-HSSL)	Stratification Variable 2 (Default/Not Default)	Stratification Variable 3 (LTV Range)	Stratification Variable 4 (FICO Score) Min	Stratification Variable 4 (FICO Score) Max	Population Count	Population %	Sample [1] Count	Sample [1] %	Materially Defective (Holt) Count
1	**HSSL**	**Default**	**LTV < 80%**	**All FICO Scores**		**3,955**	**7.4%**	**160**	**26.7%**	**58**
1a	HSSL	Default	LTV < 80%	506	616	788	1.5%	32	5.3%	12
1b	HSSL	Default	LTV < 80%	617	648	778	1.5%	32	5.3%	11
1c	HSSL	Default	LTV < 80%	649	684	794	1.5%	32	5.3%	10
1d	HSSL	Default	LTV < 80%	685	722	789	1.5%	32	5.3%	16
1e	HSSL	Default	LTV < 80%	723	819	806	1.5%	32	5.3%	9
3	**HSSL**	**Not-Default**	**LTV < 80%**	**All FICO Scores**		**33,221**	**62.5%**	**130**	**21.7%**	**25**
3a	HSSL	Not-Default	LTV < 80%	500	674	6,620	12.4%	26	4.3%	5
3b	HSSL	Not-Default	LTV < 80%	675	723	6,640	12.5%	26	4.3%	4
3c	HSSL	Not-Default	LTV < 80%	724	760	6,604	12.4%	26	4.3%	7
3d	HSSL	Not-Default	LTV < 80%	761	787	6,668	12.5%	26	4.3%	5
3e	HSSL	Not-Default	LTV < 80%	788	1000	6,689	12.6%	26	4.3%	4
5	**HSSL**	**Default**	**LTV = 80%**	**All FICO Scores**		**1,015**	**1.9%**	**30**	**5.0%**	**8**
5a	HSSL	Default	LTV = 80%	529	629	199	0.4%	6	1.0%	1
5b	HSSL	Default	LTV = 80%	630	658	203	0.4%	6	1.0%	0
5c	HSSL	Default	LTV = 80%	659	687	202	0.4%	6	1.0%	2
5d	HSSL	Default	LTV = 80%	688	721	207	0.4%	6	1.0%	1
5e	HSSL	Default	LTV = 80%	722	809	204	0.4%	6	1.0%	4
7	**HSSL**	**Not-Default**	**LTV = 80%**	**All FICO Scores**		**5,242**	**9.9%**	**30**	**5.0%**	**6**
7a	HSSL	Not-Default	LTV = 80%	506	659	1,040	2.0%	6	1.0%	2
7b	HSSL	Not-Default	LTV = 80%	660	699	1,042	2.0%	6	1.0%	1
7c	HSSL	Not-Default	LTV = 80%	700	735	1,039	2.0%	6	1.0%	2
7d	HSSL	Not-Default	LTV = 80%	736	770	1,042	2.0%	6	1.0%	0
7e	HSSL	Not-Default	LTV = 80%	771	825	1,079	2.0%	6	1.0%	1
9	**HSSL**	**Default**	**LTV > 80%**	**All FICO Scores**		**2,743**	**5.2%**	**160**	**26.7%**	**92**
9a	HSSL	Default	LTV > 80%	580	640	533	1.0%	32	5.3%	22
9b	HSSL	Default	LTV > 80%	641	665	549	1.0%	32	5.3%	19
9c	HSSL	Default	LTV > 80%	666	690	551	1.0%	32	5.3%	18
9d	HSSL	Default	LTV > 80%	691	721	552	1.0%	32	5.3%	16
9e	HSSL	Default	LTV > 80%	722	818	558	1.0%	32	5.3%	17
11	**HSSL**	**Not-Default**	**LTV > 80%**	**All FICO Scores**		**6,999**	**13.2%**	**90**	**15.0%**	**50**
11a	HSSL	Not-Default	LTV > 80%	552	657	1,379	2.6%	18	3.0%	10
11b	HSSL	Not-Default	LTV > 80%	658	688	1,401	2.6%	18	3.0%	10
11c	HSSL	Not-Default	LTV > 80%	689	720	1,413	2.7%	18	3.0%	12
11d	HSSL	Not-Default	LTV > 80%	721	757	1,380	2.6%	18	3.0%	9
11e	HSSL	Not-Default	LTV > 80%	758	827	1,426	2.7%	18	3.0%	9
	HSSL Total					**53,175**	**100.0%**	**600**	**100.0%**	**239**

Exhibit 2 (Continued)
Population Sizes and Sample Size by Cowan Stratum

Stratification						Population		Sample [1]		Findings
Cowan Stratum	Stratification Variable 1 (HSSL/Non-HSSL)	Stratification Variable 2 (Default/Not Default)	Stratification Variable 3 (LTV Range)	Stratification Variable 4 (FICO Score) Bound	Bound	Count	%	Count	%	Materially Defective Count
2	**Non-HSSL**	**Default**	**LTV < 80%**	**All FICO Scores**		**32,198**	**16.4%**	**85**	**21.3%**	**31**
2a	Non-HSSL	Default	LTV < 80%	500	582	6,331	3.2%	17	4.3%	4
2b	Non-HSSL	Default	LTV < 80%	583	623	6,454	3.3%	17	4.3%	5
2c	Non-HSSL	Default	LTV < 80%	624	656	6,435	3.3%	17	4.3%	10
2d	Non-HSSL	Default	LTV < 80%	657	699	6,507	3.3%	17	4.3%	6
2e	Non-HSSL	Default	LTV < 80%	700	824	6,471	3.3%	17	4.3%	6
4	**Non-HSSL**	**Not-Default**	**LTV < 80%**	**All FICO Scores**		**88,734**	**45.2%**	**105**	**26.3%**	**27**
4a	Non-HSSL	Not-Default	LTV < 80%	0	620	17,468	8.9%	21	5.3%	5
4b	Non-HSSL	Not-Default	LTV < 80%	621	667	18,019	9.2%	21	5.3%	8
4c	Non-HSSL	Not-Default	LTV < 80%	668	712	17,412	8.9%	21	5.3%	5
4d	Non-HSSL	Not-Default	LTV < 80%	713	762	18,007	9.2%	21	5.3%	6
4e	Non-HSSL	Not-Default	LTV < 80%	763	1000	17,828	9.1%	21	5.3%	3
6	**Non-HSSL**	**Default**	**LTV = 80%**	**All FICO Scores**		**14,118**	**7.2%**	**30**	**7.5%**	**9**
6a	Non-HSSL	Default	LTV = 80%	500	623	2,794	1.4%	6	1.5%	2
6b	Non-HSSL	Default	LTV = 80%	624	652	2,796	1.4%	6	1.5%	2
6c	Non-HSSL	Default	LTV = 80%	653	679	2,819	1.4%	6	1.5%	2
6d	Non-HSSL	Default	LTV = 80%	680	711	2,836	1.4%	6	1.5%	2
6e	Non-HSSL	Default	LTV = 80%	712	817	2,873	1.5%	6	1.5%	1
8	**Non-HSSL**	**Not-Default**	**LTV = 80%**	**All FICO Scores**		**21,945**	**11.2%**	**30**	**7.5%**	**10**
8a	Non-HSSL	Not-Default	LTV = 80%	500	631	4,375	2.2%	6	1.5%	2
8b	Non-HSSL	Not-Default	LTV = 80%	632	664	4,297	2.2%	6	1.5%	1
8c	Non-HSSL	Not-Default	LTV = 80%	665	694	4,447	2.3%	6	1.5%	3
8d	Non-HSSL	Not-Default	LTV = 80%	695	734	4,388	2.2%	6	1.5%	1
8e	Non-HSSL	Not-Default	LTV = 80%	735	1000	4,438	2.3%	6	1.5%	3
10	**Non-HSSL**	**Default**	**LTV > 80%**	**All FICO Scores**		**14,811**	**7.5%**	**85**	**21.3%**	**50**
10a	Non-HSSL	Default	LTV > 80%	500	623	2,867	1.5%	17	4.3%	10
10b	Non-HSSL	Default	LTV > 80%	624	646	2,930	1.5%	17	4.3%	11
10c	Non-HSSL	Default	LTV > 80%	647	673	3,068	1.6%	17	4.3%	11
10d	Non-HSSL	Default	LTV > 80%	674	705	2,963	1.5%	17	4.3%	9
10e	Non-HSSL	Default	LTV > 80%	706	820	2,983	1.5%	17	4.3%	9
12	**Non-HSSL**	**Not-Default**	**LTV > 80%**	**All FICO Scores**		**24,478**	**12.5%**	**65**	**16.3%**	**30**
12a	Non-HSSL	Not-Default	LTV > 80%	469	634	4,780	2.4%	13	3.3%	4
12b	Non-HSSL	Not-Default	LTV > 80%	635	664	4,997	2.5%	13	3.3%	7
12c	Non-HSSL	Not-Default	LTV > 80%	665	694	4,752	2.4%	13	3.3%	5
12d	Non-HSSL	Not-Default	LTV > 80%	695	737	4,973	2.5%	13	3.3%	7
12e	Non-HSSL	Not-Default	LTV > 80%	738	1000	4,976	2.5%	13	3.3%	7
	Non-HSSL Total					**196,284**	**100.0%**	**400**	**100.0%**	**157**

Exhibit 2 (Continued)
Population Sizes and Sample Size by Cowan Stratum

Note

[1] The sample size includes both loans that Mr. Holt re-underwrote and loans that Mr. Holt did not re-underwrite.

Sources

[1] 2013.05.02 Final Data File.csv, file produced by Plaintiff.
[2] 2012-12-27 -- Data to SDNY -- US v Bank of America -- Confidential.xlsx, file produced by Plaintiff.
[3] Sample.r, file produced by Plaintiff.
[4] John A. Rice, *Mathematical Statistics and Data Analysis* , Second Edition, Duxbury Press, 1995.

Exhibit 3
Non-Rebutted Defect Rates by Cowan Stratum

Cowan Stratum	Stratification Variable 1	Stratification Variable 2	Stratification Variable 3	Not Materially Defective (Holt)	Materially Defective (Holt)		Non-Rebutted Defect Rate [1]	Margin of Error Assuming that Re-Underwritten Loans Were a Random Sample of All Sampled Loans [2]	P Value, Test of Equality of Defect Rates [3]
					Rebutted Loans	Non-Rebutted Loans			
1	HSSL	Default	LTV < 80%	82	50	8	5.7%	3.9%	0.898
2	Non-HSSL	Default	LTV < 80%	36	27	4	6.2%	6.7%	
3	HSSL	Not-Default	LTV < 80%	94	21	4	3.3%	3.6%	0.983
4	Non-HSSL	Not-Default	LTV < 80%	63	24	3	3.3%	4.0%	
5	HSSL	Default	LTV = 80%	19	6	2	8.1%	12.9%	0.827
6	Non-HSSL	Default	LTV = 80%	21	6	3	10.0%	12.0%	
7	HSSL	Not-Default	LTV = 80%	21	5	1	4.0%	10.3%	0.414
8	Non-HSSL	Not-Default	LTV = 80%	15	7	3	12.4%	17.4%	
9	HSSL	Default	LTV > 80%	40	80	12	9.3%	4.8%	0.557
10	Non-HSSL	Default	LTV > 80%	23	41	9	12.0%	7.6%	
11	HSSL	Not-Default	LTV > 80%	31	45	5	6.2%	5.5%	0.566
12	Non-HSSL	Not-Default	LTV > 80%	24	28	2	3.9%	5.5%	
All Sampled HSSL Loans				287	207	32	4.3%	2.6%	0.430
All Sampled Non-HSSL Loans				182	133	24	6.0%	3.1%	

Exhibit 3 (Continued)
Non-Rebutted Defect Rates by Cowan Stratum

Notes

[1] As in Exhibit 1, let *h* index the HSSL or non-HSSL stratum, *i* index default/LTV stratum within HSSL or non-HSSL stratum, and *j* index FICO stratum within HSSL/default/LTV stratum.

Also, let b_{hij} equal Mr. Broeksmit's rebuttal rate of defective loans in stratum *hij* (i.e., the proportion of defective loans in stratum *hij* that Mr. Broeksmit found to be non-defective). Then let q_{hij} = (1 - b_{hij}) equal the non-rebuttal rate of defective loans in stratum *hij*.

Using this terminology, the estimated non-rebutted defect rate in HSSL-Default-LTV-FICO stratum *hij* is:

$$r'_{hij} = r_{hij} q_{hij}$$

where r_{hij} is Mr. Holt's defect rate in stratum *hij*.

The estimated non-rebutted defect rate in HSSL-Default-LTV stratum *hi* is:

$$r'_{hi} = \sum_{j=1}^{5} W_{hij}\, r'_{hij}$$

where W_{hij} is as defined in Exhibit 1.

Similarly, the estimated non-rebutted defect rate for HSSL (or non-HSSL loans) is:

$$r'_{h} = \sum_{i=1}^{6} W_{hi}\, r'_{hi}$$

Where W_{hi} is as defined in Exhibit 1.

[2] Assuming that the loans that Mr. Holt re-underwrote were a random sample of the loans that Dr. Cowan sampled, the margin of error of the estimated non-rebutted defect rate r'_{hij} in HSSL-Default-LTV stratum *hi* is:

$$MOE'_{hi} = \pm 1.96\sqrt{S'^2_{hi}}$$

where

s_{hij} = the number of loans in stratum *hij* sampled by Dr. Cowan and re-underwritten by Mr. Holt,

S^2_{hij} = the estimated variance of the Holt defect rate r_{hij}, is as defined in Exhibit 1,

$S^2_{q,hij} = \left[\frac{q_{hij}(1-q_{hij})}{r_{hij}s_{hij}-1}\right]\left[1-\frac{r_{hij}s_{hij}}{r_{hij}n_{hij}}\right]$, the estimated variance of the non-rebuttal rate q_{hij},

$S'^2_{hij} = r^2_{hij}S^2_{q,hij} + q^2_{hij}S^2_{hij} + S^2_{hij}S^2_{q,hij}$, the estimated variance of the non-rebutted defect rate r'_{hij},

$S'^2_{hi} = \sum_{j=1}^{5} W^2_{hij}\, S'^2_{hij}$, the estimated variance of the non-rebutted defect rate $r'_{hi,}$

and other variables are as defined as above and in Exhibit 1.

Similarly, the margin of error of the estimated non-rebutted rate for HSSL (or non-HSSL) loans is equal to:

$$MOE'_h = \pm 1.96\sqrt{S'^2_h}$$

where

$S'^2_h = \sum_{i=1}^{6} W^2_{hi}\, S'^2_{hi}$, the estimated variance of the non-rebutted defect rate $r'_{h,}$

and other variables are as defined as above and in Exhibit 1.

[3] The p-value is the p-value of a two-sided test of the equality of non-rebutted defect rates, assuming the defect rates are independent normally distributed random variables.

To test the equality of non-rebutted defect rates, both in like default/LTV stratum and between HSSL and non-HSSL loans, I follow the method described in Exhibit 1, Note [3], substituting "non-rebutted defect rate" for "defect rate" in all calculations.

Sources

[1] 2013.05.02 Final Data File.csv, file produced by Plaintiff.
[2] 2012-12-27 – Data to SDNY – US v Bank of America – Confidential.xlsx, file produced by Plaintiff.
[3] Sample.r, file produced by Plaintiff.
[4] FINAL TRELIANT DECISIONING_061613 12 noon.xlsx
[5] John A. Rice, *Mathematical Statistics and Data Analysis*, Second Edition, Duxbury Press, 1995.